(12) UK Patent Application (19) GB (11) 2 210 957 (13) A

(43) Date of A publication 21.06.1989

(21) Application No 8823957.9

(22) Date of filing 12.10.1988

(30) Priority data
(31) 3078183 (32) 12.10.1987 (33) DD

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(51) INT CL⁴
F16K 11/10

(52) UK CL (Edition J)
F2V VA30
U1S S1614

(56) Documents cited
US 4741354 A

(58) Field of search
UK CL (Edition J) F2V VA30
INT CL⁴ F16K

(54) Valve block for pressure-change adsorption installations

(57) A valve block for use in the control of a multi-adsorber pressure-change adsorption installation serving for the adsorptive separation of gas mixtures has pressure-operated, preferably diaphragm-type, adsorber valves (2) therein. The adsorber valves allocated to an adsorber are connected in a row with one another through an adsorber gas conduit (1). The valve block has recesses (3) on the adsorber valves, forming parts of the adsorber gas conduits. Pipes (6) form annular gaps with the recesses 3 and each pipe leads by way of cross-type junction (5) to product gas conduits (4). The axis of each pipe (6) leading to the product gas conduit and the axis of an adsorber gas conduit intersect. Each product gas conduit (4) thus leads by way of the cross-type junction (5) to several adsorber valves arranged in different adsorber gas conduits (1) and thus is in communication with all adsorbers.

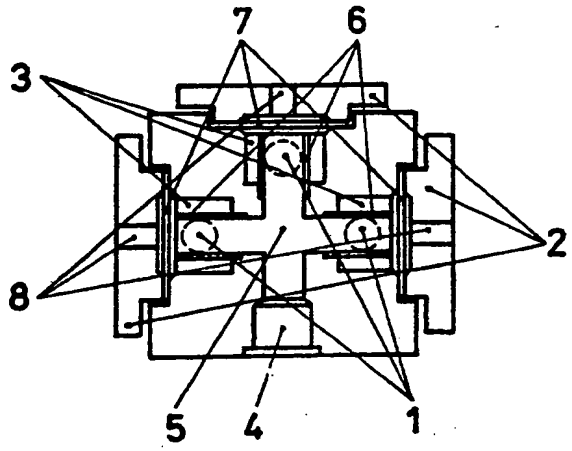

Fig. 2

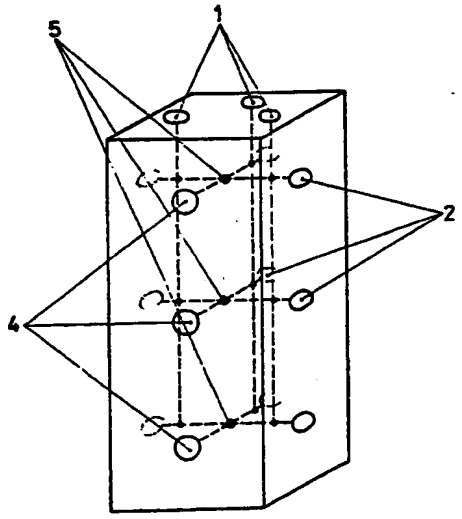

Fig. 3

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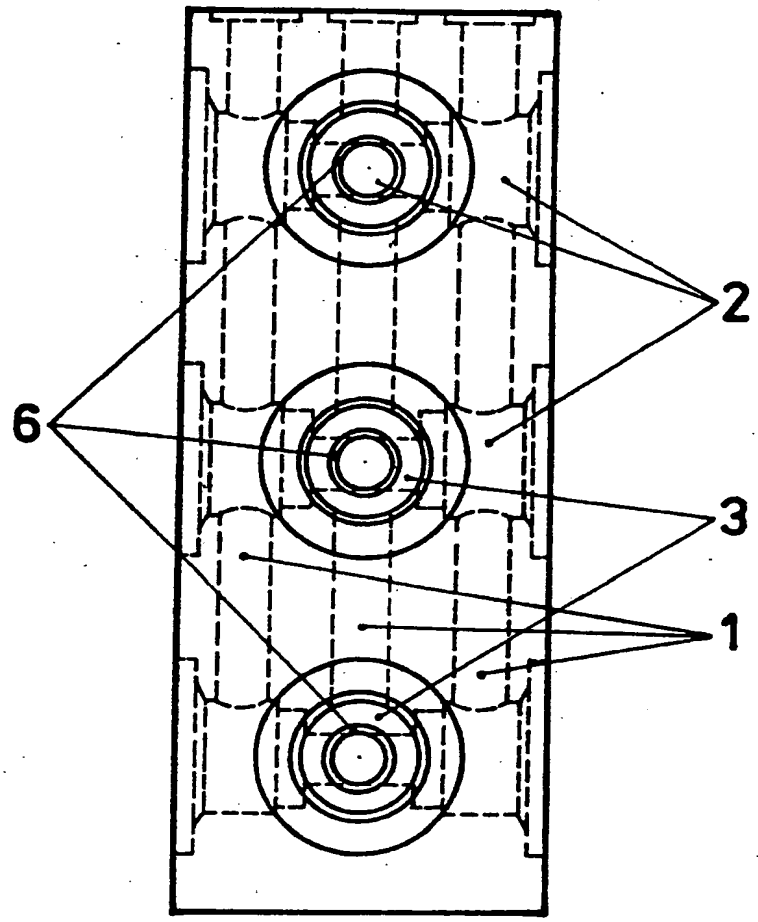

Fig. 1

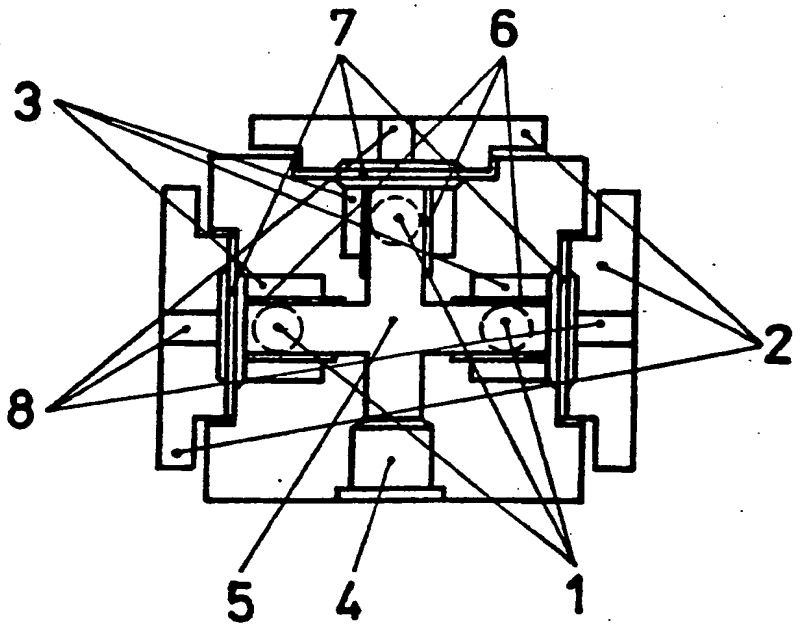

Fig. 2

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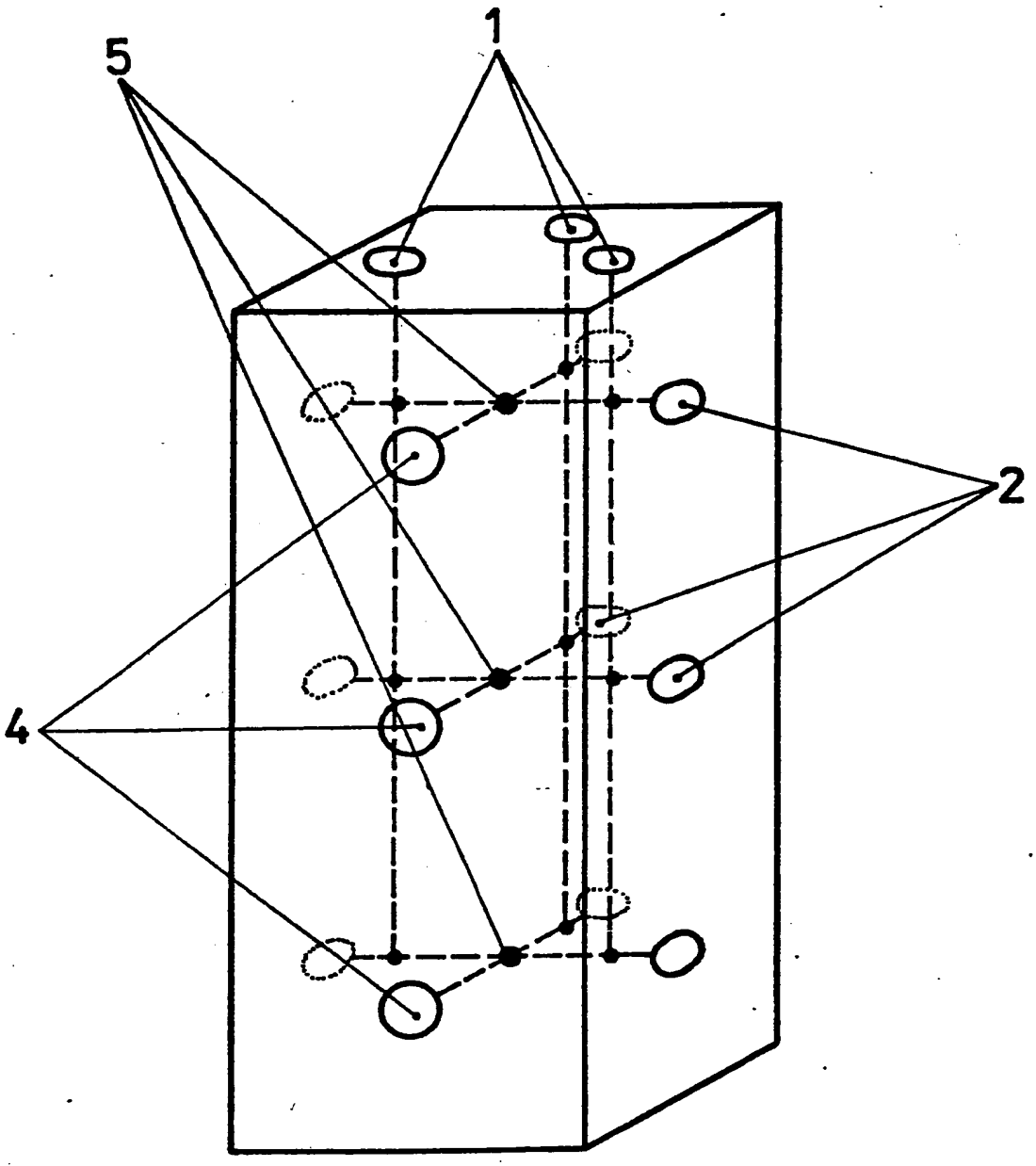

Fig. 3

VALVE BLOCK FOR PRESSURE-CHANGE ADSORPTION INSTALLATIONS

The invention relates to the controlling of pressure-change adsorption installations which serve for the adsorptive separation of gas mixtures, especially for the extraction of oxygen or nitrogen from the air.

Adsorption methods are frequently used nowadays for the separation of gas mixtures, on account of their economy and effectiveness. Methods working with changing pressure have proved their value especially in recent times. In these methods the desorption of the charged adsorbent is effected by a pressure reduction, which is frequently completed by the use of a scavenging gas.

The known pressure-change adsorption installations comprise a plurality of valves for the control of the gas. These valves considerably increase the expense of materials and costs. Therefore one endeavours to reduce the expense occuring due to the valves.

For this purpose it is known from DE-OS, 3,310,759 to assemble in one valve block the valves integrated into the main connection conduits. The valve blocks are provided at the gas inlet and at the gas exit of the adsorber. The pipework of the adsorbers is considerably reduced by the valve blocks. However the design configuration of these valve blocks is not described in DE-OS 3,310,759.

It is an object of the invention to provide an improved valve block usable with adsorption installations.

According to the invention there is provided a valve block for use in pressure-change adsorption installations;

said block having a plurality of pressure actuated adsorber valves arranged to be in communication through adsorber gas conduits with adsorbers of the installation and with product gas conduits for the gases entering and emerging from the adsorbers, with the adsorber valves which are allocated to one adsorber being interconnected as a row by one of the adsorber gas conduits, recesses in the valve block for the adsorber valves, the recesses forming parts of the adsorber gas conduits and a pipe engaged in each of the recesses and leading by way of a junction to a port on the block for connection to one of the product gas conduits; wherein each pipe forms an annular gap with the associated recess with the axis of the pipe leading to one of the product gas conduits and the axis of an adjacent one of the adsorber gas conduits intersecting.

The valve block expediently consists of aluminium or of a thermoplastic synthetic plastics material. In the latter case such a valve block can be produced by injection-moulding.

A valve block in accordance with the invention has the adsorber valves, provided on the inlet or outlet side of the adsorbers, pertaining to the pressure-change adsorption installation arranged side by side in minimum space.

Each adsorber gas conduit leads from the valve block to an adsorber and there opens into the adsorber on one

side thereof. Product gas conduits for the gases flowing by way of the adsorber gas conduits into the adsorbers and the gases flowing out of the adsorbers further lead to the valve block. The adsorber valves are connected with the product gas conduits through the junctions, as a rule of cross-type formation, situated in the valve block. An adsorber valve thus opens or closes the connection between a product gas conduit and an adsorber gas conduit. It is possible for the gas from one of the product gas conduits to flow through the junction through the pipe and the recess into the adsorber gas conduit.

Since an adsorber gas conduit leads from each adsorber into the valve block, the number of adsorber gas conduits situated in the valve block corresponds to the number of the adsorbers used in the pressure-change adsorption installation.

At the end of the pipe opposite to the product gas conduit a diaphragm is arranged which is in a position to close the passage opening formed by the pipe end, when it is charged with control gas. Since the passage opening is a constituent of an adsorber valve, in this way the adsorber valve is closed when the diaphragm is charged with control gas.

In the case of pressure-change adsorption installations with three adsorbers the adsorber gas conduits and the product gas conduits are interchangeable, by reason of their arrangement on the valve block. Therefore at every location on the valve block where the

product gas conduits open into the valve block the adsorber conduits can enter in place of the product gas conduits. In this case the product gas conduits are arranged at that position where otherwise the adsorber gas conduits are provided. In this case the adsorber valves in the product gas conduits form one row in the valve block.

In order to render possible an automatic start-up of the installation, the adsorber valves through which the gas mixture (for example air) which is to be subjected to an adsorption process in the adsorbers enters the valve block are provided each with a pressure intensifier. Such a pressure intensifier consists of a second diaphragm and a thrust element both of which are arranged on the side remote from the passage opening of the adsorber valve, of the diaphragm closing the passage opening. In this case the area of the second diaphragm charged by control gas is larger than the area of the passage opening of the adsorber valve. Between the two diaphragms the thrust element transmits the pressure exerted upon the second diaphragm to the diaphragm arranged on the passage opening.

A pressure-balancing valve in communication with the pressure-balancing valves of the other adsorber gas conduits is expediently arranged in the valve block in each adsorber gas conduit. In this way in the valve block the adsorber valves pertaining to an adsorber and a

pressure-balancing valve are arranged in each adsorber gas conduit. The pressure-balancing valve is opened when a pressure equalisation is to take place between two adsorbers.

A valve block is allocated in each case to one adsorber side of several adsorbers. A pressure-change adsorption installation thus comprises two valve blocks.

By product gas conduits there are to be understood within the meaning of the invention the conduits through which the product gases are fed to the valve blocks or conducted away from them. Product gases are the gas mixture (for example air) to be separated, scavenging gas, residual gas and the recovered approximately pure gas (for example oxygen). In contrast thereto, by adsorber gas conduits there are to be understood the conduits arranged between the adsorbers and the valve blocks.

The invention brings the advantage of a considerable saving of material and weight and a good possibility of monitoring the adsorber valves pertaining to the installation.

The invention may be understood more readily and various other features of the invention may become apparent from consideration of the following description.

An embodiment of the invention will now be described, by way of example with reference to the accompanying drawings wherein:-

Figure 1 shows longitudinal section through a valve block, constructed in accordance with the invention;

Figure 2 shows a cross-section through the valve block; and

Figure 3 shows an three-dimensional representation of the valve block in communication with the lower adsorber side.

In a pressure-change adsorption plant or installation oxygen is to be recovered from air in a concentration of about 92% vol. The installation possesses three adsorbers which are arranged vertically beside one another. A valve block is in communication through adsorber gas conduits with each of the lower and the upper ends of the adsorbers. The two valve blocks possess the same design configuration, only the nature of the supplied gases are different. The valve block allocated to the lower adsorber end will be described below.

The valve block is composed of aluminium and has the form of a parallelepiped with square end surfaces. Three adsorber gas conduits 1, which connect the valve block with the lower ends of the associated adsorbers, lead - as may be seen from Figure 3 - from the upper end of the valve block into the latter. In the valve block three adsorber valves 2 are arranged in each of the three adsorber gas conduits 1 so that the valve block comprises a total of nine adsorber valves 2. Here in each case three adsorber valves 2 form a row on three outer faces of the valve block. Thus in the valve block in each adsorber

gas conduit 1 three adsorber valves are arranged one behind another. The adsorber valves 2 are formed as valves which are closed when subject to the action of control air.

Each adsorber valve 2 in the valve block has a cylindrical recess 3 forming a part of the associated adsorber gas conduit 1. The adsorber gas conduits 1 thus consist of longitudinal bores the valve block and the recesses 3.

Three product gas conduits 4, through which different gases are fed to and conducted away from the valve block, lead to a fourth external surface of the valve block, in which no adsorber valves 2 are arranged. The product gas conduits 4 are at right angles to the adsorber gas conduits 1. The product gas conduits 4 have cross-type junctions 5 in the valve block, from which three gas conduits lead each through an inserted pipe 6 to an adsorber valve 2. Each pipe 6 forms an annular gap with one of the recesses 3 and the area of this annular gap corresponds to the internal cross-sectional area of the pipe 6.

The axis of each pipe 6 intersects an axis of one of the adsorber gas conduits 1. The three product gas conduits 4 thus divide in the valve block and each leads to three adsorber valves 2. Thus when an adsorber valve 2 is in the opened position gas can flow out of the product gas conduit 4 into an adsorber gas conduit 1 or vice versa.

A diaphragm 7 is allocated to each of the pipes 6 at right angles thereto. The diaphragm 7 can consist of elastic polyurethane. A control air conduit 8 leading to a control valve (not shown) is provided on the side of the diaphragms 7 remote from the pipes 6. The control valve is a three-part valve with one part serving for the venting of the control air conduit 8 in the case where the diaphragm 7 is not charged with control air.

For greater clarity in Figure 3 the control air conduit 8 is not illustrated. The arrangement of the diaphragms 7 in relation to the pipes 6 takes place in such a way that when the diaphragms 7 are charged with control air coming through the control air conduit 8 and from a control valve, the diaphragm 7 rests on the pipe 6 and thus blocks the gas passage. If the adsorber valve 2 is opened, then the gas flows out of the adsorber gas conduit 1 through the annular gap past the diaphragm 7 into the pipe 6, or vice versa. On their outsides the adsorber valves 2 are provided with a valve cover through which the control air conduit 8 leads. Therefore, strictly speaking in Figure 2 and Figure 3 it is the valve covers which have been provided with the reference 2.

In another form of embodiment of the valve block which is allocated to the upper end of the adsorbers (not illustrated in the drawing), a pressure-balancing valve is arranged in the valve block in each adsorber gas conduit 1 as well as the three adsorber valves 2, and is connected

with the pressure-balancing valves of each other adsorber gas conduit by a gas conduit. These pressure-balancing valves form with the three adsorber valves 2 one row in each case in each adsorber gas conduit 1. The pressure-balancing valves are formed in the same way as the absorber valves 2. During the operation of the pressure-changer adsorption installation they are closed by charging with control gas. Only during the pressure equalisation between two adsorbers are the two pressure-balancing valves of the adsorbers participating in the pressure equalisation opened. At this moment all the adsorber valves 2 arranged in the two valve blocks are closed. In order to guarantee a secure opening and closing of the three adsorber valves 2, which are connected with the product gas conduit 4 through which the compressed air flows into the valve block, in the start-up of the pressure-change adsorption installation, these adsorber valves 2 are provided with a pressure intensifier. These pressure intensifiers consist of a second diaphragm which is spaced from the diaphragm 7 situated on the passage opening of the adsorber valve, and of a movable thrust element which is provided between the two diaphragms. The area of the second diaphragm upon which control gas acts is larger than the area of the passage opening of the adsorber valve 2. The thrust element transmits the pressure exerted upon the second diaphragm to the diaphragm 7 arranged on the passage opening. In this way a smaller pressure suffices for

closing the appropriate adsorber valves 2, in the start-up of the installation.

During the operation of the pressure-change adsorption installation compressed air, which is to be subjected in an adsorber to an adsorption process, passes through the central product gas conduit 4 of the lower valve block. The compressed air passes from the product gas conduit 4 to the junction 5 and then to the three pipes 6 and thus to the three adsorber valves 2. Two of the three adsorber valves 2 are closed by the charging with control air through the control air conduit 8, the third adsorber valve 2, which is arranged in the adsorber conduit 1 leading to the adsorber in which the adsorption process takes place, is opened. The compressed air passes in the opened adsorber valve 2 through the pipe 6 past the diaphragm 7 into the aperture 3 and passes from there through the adsorber gas conduit 1 to the lower end of the respective adsorber. The charging of the diaphragms 7 with control air and thus the opening and closing of the adsorber valves 2 take place with the aid of an electronic control system subject to time control with control air being conducted to the adsorber valves 2 in each case through control valves and through the control air conduits 8.

While the adsorption process is taking place in one adsorber, the desorption process is taking place in the second adsorber with simultaneuous scavenging and the

third adsorber is being prepared by scavenging with nearly pure oxygen for a renewed adsorption process. In this operation the scavenging gas coming from the third adsorber passes by way of an adjacent adsorber gas conduit 1 from above into the lower valve block, flows within the valve block downwards in this adsorber gas conduit 1 to the lowermost adsorber valve 2, which is opened, while the two adsorber valves 2 lying thereabove and arranged in this adsorber gas conduit 1 are closed, flows through the lowermost adsorber valve 2 and thus through the lowermost pipe 6 and through the lowermost junction 5 into the lowermost product gas conduit 4. Since the two other lower adsorber valves 2 are closed, the scavenging gas can flow only into the lower product gas conduit 4. The lower product gas conduit 4 leads as scavenging gas conduit to the valve block allocated to the upper adsorber side and thence into the second adsorber. The now heavily soiled scavenging gas issuing from the second adsorber passes from above, just like the residual gas occuring in the desorption, through the third adsorber gas conduit 1 into the valve block. There only the upper adsorber valve 2 is opened in this adsorber gas conduit 1. The soiled scavenging gas passes through the upper adsorber valve 2 and arrives in the upper junction 5. Since the other two upper adsorber valves 2 are closed, the soiled scavenging gas can flow only through the upper product gas conduit 4, through which it leaves the valve block and the pressure-change adsorption installation. In this way

during the adsorption process three of the nine adsorber valves 2 of the valve block are opened and six are closed.

After termination of the adsorption process in the first adsorber a pressure equalisation takes place between the first and the third adsorbers. At this moment all nine adsorber valves 2 of the valve block are closed.

When the pressure equalisation is terminated, the following adsorption process takes place in the third adsorber. In this process compressed air is still conducted through the middle product gas conduit 4 into the lower valve block, which air passes through the middle junction 5 through that adsorber valve 2 which is arranged in the adsorber gas conduit 1 leading to the third adsorber. The other two middle adsorber valves 2 are here closed. Scavenging gas coming from the second adsorber passes by way of the adjacent adsorber gas conduit 1 from above into the valve block, flows down within the valve block in this adsorber gas conduit 1 to lower adsorber valve 2, which is opened, while the two adsorber valves 2 lying thereabove and arranged in this adsorber gas conduit are closed, passes through the lower adsorber valve 2 and thereafter through the lower junction 5 into the lower product gas conduit 4. The other two lower adsorber valve 2, which are arranged in the adsorber gas conduits 1 leading to the first adsorber and to the third adsorber, are closed at this moment. The scavenging gas flowing in the lower product gas conduit 4 is conducted into the

upper part of the first adsorber. It flows through the first adsorber, emerges at its lower part into the third adsorber gas conduit 1 and then flows from above into the valve block. There only the upper adsorber valve 2 is opened in this adsorber gas conduit 1. The soiled scavenging gas passes through the upper adsorber valve 2 and arrives in the upper junction 5. Since the other two upper adsorber valves 2 are closed, the soiled scavenging gas flows only through the upper product gas conduit 4 out of the valve block.

When the adsorption process in the third adsorber is terminated, a pressure equalisation takes place with the second adsorber, whereupon there follows a renewed adsorption process in the second adsorber. In this again in the valve block the adsorber valves 2 necessary for the control of the gas currents are opened and closed as appropriate.

The valve block which is allocated to the three adsorbers with a volume of 10 l. each itself possesses a volume of 2,600 cc. Its weight amounts to 8,600 g.

CLAIMS

1. A valve block for use in pressure-change adsorption installations; said block having a plurality of pressure actuated adsorber valves arranged to be in communication through adsorber gas conduits with adsorbers of the installation and with product gas conduits for the gases entering and emerging from the adsorbers, with the adsorber valves which are allocated to one adsorber being interconnected as a row by one of the adsorber gas conduits, recesses in the valve block for the adsorber valves, the recesses forming parts of the adsorber gas conduits and a pipe engaged in each of the recesses and leading by way of a junction to a port on the block for connection to one of the product gas conduits; wherein each pipe forms an annular gap with the associated recess with the axis of the pipe leading to one of the product gas conduits and the axis of an adjacent one of the adsorber gas conduits intersecting.

2. A valve block according to Claim 1, wherein the number of the adsorber gas conduits corresponds to the number of the adsorbers in the pressure-change adsorption installation.

3. A valve block according to Claim 1 or 2, wherein the adsorber valves have passage openings on which there are arranged diaphragms which are capable of closing the valves.

4. A valve block according to any one of Claims 1 to 3, wherein the adsorber valves intended for the adsorption

gas entry are each provided with a pressure intensifier.

5. A valve block according to Claim 4, when appended to Claim 3, where the pressure intensifier consists of a second diaphragm spaced from the first-mentioned diaphragm and a thrust element between the diaphragms, the second diaphragm being arranged on the side remote from the passage opening of the adsorber valve, the area of the second diaphragm which is subject to the action of control gas being greater than the area of the passage opening.

6. A valve block according to any one of Claims 1 to 5, wherein the junctions are of cross-type formation.

7. A valve block according to Claims 1 to 6, and further comprising a pressure-balancing valve arranged in each adsorber gas conduit, which valve is in communication with the pressure-balancing valves of every other adsorber gas conduit.

8. A valve block according to any one of Claims 1 to 7, wherein the block is adapted for use with a pressure-change adsorption installation having three adsorbers and the adsorber gas conduits and the product gas conduits are exchangeable with one another in their arrangement on the valve block.

9. A valve block substantially as described with reference to, and as illustrated in, the accompanying drawings.

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